I dedicate this species to M. Valenciennes, whose talents and associations with Lamarck and Cuvier place him in the first rank among our European scientific men.

The only specimen known belongs to the Garden of Plants; and in order to illustrate the distinctions between the three genera of this small family, I have given in Pl. XV. profile views of *Magas* (fig. 2), and *Bouchardia* (fig. 3), which thus express to the eye what the writer of this paper has been unable to describe.

Fig. 1 is the natural size of *Waltonia Valenciennesii*; the other figures are enlarged.

I have also here to express my thanks to my old friend M. Bouchard, to whom I exposed my views on this new genus, and in which he completely concurred.

XLIII.—*On the Operculum of Gasteropodous Mollusca, and an attempt to prove that it is homologous or identical with the second Valve of Conchifera.* By J. E. Gray, Esq., F.R.S.

To the Editors of the Annals of Natural History.

Gentlemen,

Having for several years entertained the opinion that the operculum of Gasteropods is identical with the second valve of bivalve shells, and having in the 'Synopsis' of the British Museum for 1842, and in several papers on Mollusca, mentioned it in that light, without any naturalist having attempted in any way to dispute the theory, I was induced to believe that it had been adopted as an axiom; but having lately mentioned the fact in the presence of Mr. Owen and several other comparative anatomists, and finding that they were not prepared to admit the propriety of the comparison, I have been induced to put on paper the reasons which led me to adopt the theory, which I have neglected to do before. I am the more induced to do so, as on reading Professor Lovèn's paper, I find that that very accurate and profound malacologist, who has paid much attention to the relation which the different classes of Mollusca bear to each other and the homologies of the different organs, though he has observed that these Mollusca are provided with a particular part, before very generally overlooked, which he calls the *lobus operculigerus*, but which I have long ago described as the mantle of the operculum, yet considers the operculum as analogous to *byssus*. His observations are as follows:—

"The Gasteropods have also another part of the foot, which may be named *lobus operculigerus*, sometimes highly developed

as in *Atlanta*, sometimes very reduced; on its middle the *byssus* is secreted, whose filaments when present are always united into a disc-like *operculum*.

"The side part of the lobe is sometimes produced into cirri, as in *Rissoa*, *Lacuna*, &c., sometimes into a large extensible membrane capable of covering the whole shell."—*Lovèn, Ofvers. Kongl. Vetensk. Akad. Fork.* 1847.

In a paper on the Structure of Shell in the Philosophical Transactions for 1833, I showed with considerable detail that the operculum of the Gasteropodous Mollusca, like the shelly valve of those animals,

1. Is developed on the embryo long before it is hatched.

2. That it is placed on and covers a peculiar part of the body, which bears the same relation to it as the part of the body called the mantle bears to the part usually called the shell of these animals; and it is formed and increased in size by an opercular mantle in the same way as the shells are.

3. That the operculum is more or less conical, and is increased in size by the addition of new matter to the inner surface, and especially to the surface near the margin; the new matter either forming more or less complete rings round the nucleus (or first-formed part), when they are called *annular*, and are homologous to the simply conical shell, as the *Patella*; or else the new matter is deposited almost entirely on one edge of the nucleus, when the operculum forms a more or less elongated cone, which, when long, is spirally twisted round an imaginary axis (like a spiral shell), the broad part of the cone being next the edge of the opercular mantle which secretes the new matter for enlarging its size, as the mouth of the shell is on the outer edge of the mantle of the univalve shell.

4. That the operculum is attached to the animal by means of one or more muscles, which, as in the bivalve shell, pass from the larger valve or shell to the smaller one or operculum.

5. The operculum as it increases in size is gradually moved on the end of the muscle; the many-whorled operculum of the *Trochi* revolves as many times on the end of the muscle, as the many-whorled spiral shell turns on its imaginary axis.

6. The operculum is moulded on the opercular mantle, and is often lined internally with a shelly coat like a shell; and sometimes, like the shell of the Cowries, it has its outer surface covered with a shelly coat deposited by some special development of the opercular mantle especially destined for the purpose, as is the case in the Cowries and some other shells.

From these observations it would appear, that the *operculum* has all the characters of the part of the animal which has been usually considered as the shell.

In the paper before referred to, I stated, "The operculum agrees with the valve of shells in being developed on the embryo while included in the egg, and in increasing in size by the addition of new matter round the circumference of the base of the cone of which they are formed. They also agree in the cone being sometimes simple and straight, and sometimes curved into a spiral form." The principal difference between the operculum and the valve or shell of the Gasteropods consists—

1. In the operculum having no cavity, the cone of which it is formed being either very much depressed, so as to become nearly flat or even concave, as in the annular or subannular operculum; or very much compressed, forming only a spiral riband, as in the spiral operculum.

2. The operculum of by far the greater number of Gasteropods is only formed of animal matter, so that the operculum is as if formed entirely of what constitutes the periostraca or *drap marin* of the shelly valves; but the shells of some Gasteropods, as that of the *Aplysia*, *Bullæ*, and of some land mollusks, and the valves of some bivalves, as *Lingula*, have only a very thin shelly internal layer, strengthening the thick periostraca; on the other hand, many opercula, like the generality of shells, have a shelly coat deposited on the inner side of the horny or periostracal coat, and others have the outer surface of this part, like *Cypræa* and some other genera of shells, covered with a shelly coat.

The absence of a cavity is a difference only of degree, for the valves of some Gasteropods, as *Umbrella* for instance, are so flat as to produce no cavity, and thus greatly resemble the annular opercula of *Ampullaria* and *Paludina*, as the flat valves of some *Calyptræ* are like the spiral opercula of *Littorinæ*; but the greatest resemblance is to be observed in the small flat valves of *Gryphæa*, *Exogyra*, *Chama*, and other genera of bivalve shells which are attached by one of their valves. These valves are often quite as flat and destitute of any cavity as the operculum of any Gasteropod; and it is to be remarked that these valves exactly resemble a spiral operculum in shape, the remains of the ligament forming a spiral mark on the outer surface, showing how the valve has rotated on the body of the animal as the operculum rotates on the foot of the Gasteropods.

Having thus shown the reasons which induced me to regard the operculum to be a modification of the other or shelly valve of a Gasteropod mollusk, I shall now proceed to show why I have been induced to believe that it is analogous to the second valve of a bivalve.

In the Philosophical Transactions for 1833 I remarked, "A bivalve shell is composed of a dextral and a sinistral valve united together by a ligament. When the two valves are separated and

spread out on a table, with the umbones above and the front end towards the observer, the valve to the right (the left when on the animal and in its usual walking position) resembles a dextral, and that on the left a sinistral, very depressed, spiral shell. This is well illustrated by comparing the left valve of an *Isocardia* with a *Concholepas*.

"In some very rare instances these shells also are reversed, but the fact is not easily observed except in the unequal-valved kinds. There were formerly in the Tankerville collection (they are now in the Museum) two specimens of *Lucina Childreni*, in one of which the right valve was a dextral shell in opposition to the general structure. A much more remarkable variation is to be observed in some of those bivalve shells whose under valve is attached to foreign bodies; thus for example, most of the *Chamæ* are attached by their left valve, but some species, such as *Chama Lazarus*, are frequently attached by the right valve, under which circumstance the teeth proper to the left and usually attached valve are transferred to the right, and *vice versâ*."—*Gray, Phil. Trans.* 1833, 776.

"In bivalve shells the apex of each valve is always placed on or near the dorsal or upper margin, varying its position on this part in the different groups. Thus in the *Pectines* and other suborbicular shells, which having a very large subcentral posterior adductor muscle, were called by Lamarck *Monomyaires*, the apex is generally in or near the centre; while in most of the other genera it is placed more or less towards the anterior extremity of this margin, and is sometimes incurved.

"In some of these shells the apex is spirally twisted, and the spire becomes more developed as they increase in size.

"Now this could not take place if the valves remained inseparably united together at the same part of the dorsal margin, but it is provided for by the hinge of the shell being gradually moved backwards on the edge of the valves, the ligaments separating in front of the hinge into two parts, one of which diverges along each of the umbones and forms a spiral groove down the suture of the whorls. In *Isocardia* the umbones seldom make more than half a turn, but in one specimen of *Chama* in my collection they have made an entire revolution, and in another a revolution and a half. The valves of these shells being unequal, the spiral part of the lower or attached valve is produced into an elongated cone, while in the other it is depressed and simply marked with a spiral groove like that of an operculum."—*Phil. Trans.* 1833, 775.

It thus appears that the valve of a bivalve shell resembles the univalve shell of a Gasteropodous mollusk—

1. In shape, one valve being like a dextral, and the other like a sinistral univalve.

2. That, like the univalves, these valves are sometimes reversed.

3. That the valves move on the body of the animal as the univalve shells do, to allow the deposition of new shelly matter to the margin; the position of the hinge on the margin being gradually altered to allow of this motion.

The operculum agrees with the second valve of a bivalve in all the preceding particulars.

1. The position of the nucleus of the annular operculum, or the spire of the spiral operculum, is always twisted in an opposite direction from that of the shell to which it belongs, as is the case with the two valves of a Conchiferous mollusk. This is easily observed by comparing the position of the nucleus of the dextral and sinistral genera of *Ampullariadæ*, or the spiral operculum of a sinistral malformation of a Gasteropodous mollusk with that of one of the normal form.

2. These valves are sometimes reversed, as in the instances above cited.

3. The operculum moves on the foot as the valves do on the body, and they always bear the same relative situation to the valves as the valves do to each other. In the 'Synopsis' of the British Museum for 1842, p. 56, when referring to the Phytophagous Gasteropods, I observed, "Many of them have a spiral operculum or lid which is attached to the back of the hinder part of the foot of the animal. This operculum turns round backwards on the apex of its spire as it increases in size by the addition of new matter to the edge of its last whorl, so that this edge is always in the same position in the mouth of the shell."

The two valves of the bivalve move at the same rate, and therefore the lower attached valve of the *Chama*, which often has the apex produced into a conical tip like the spire of a univalve, and marked like it with a spiral groove formed by the remains of the cartilage, similar to the suture of the whorls; and the flat valve with its simple spiral groove has the same number of twists in the flat and the elevated spire of the two valves. The same appears to be the case with the opercula of univalves, as the number of volutions of the operculum appears to bear a relation to the number of whorls in the shelly valve. Thus all the shells which have many gradually increasing whorls, as the *Trochi*, *Turritellæ* and *Cerithia*, have also an operculum with many whorls which very gradually increase in size; while the *Littorinæ*, *Neritæ*, and *Naticæ*, which have a few more or less rapidly increasing whorls, have an operculum of that character which have hence been called neritoids; but there appear to be some exceptions to this rule, which require examination.

In addition to these similarities it may be observed, that the operculum, like the two valves of a bivalve, is united to the valve

of the univalve shell by muscles passing from one to the other, which by their contractions bring them together. The forms of the muscles which are used for this purpose differ in disposition and number according to the form of the mouth of the shell or the form of the valves. Thus when the valves are nearly circular, or the mouth of the univalve shell and the operculum moderate, the muscles form only a single group; on the contrary, when the valves are oblong elongate, or the mouth of the univalve shell very large, they form two groups of muscular fibres, one on each side of the valve or cavity of the shell and operculum.

This attachment of the operculum is important; for some conchologists appear to have regarded the opercula of Gasteropodous Mollusca as analogous to the accessorial valves of certain bivalves, such as the genus *Pholas*, which they have remarked are formed in the same manner as the true valves, by the addition of new shelly matter to the edge. But these accessorial valves are never affixed to the animal by muscle, while the operculum, as above described, is attached to the animal, and is affixed to the other valve just in the same manner as the two primary valves of a bivalve are affixed to each other.

Other conchologists, because the plug which passes through the sinus of an *Anomia* has been called an operculum or stopper, have regarded the operculum of Gasteropods as analogous to that substance, overlooking the fact that the plug of the *Anomia* is but a modification of the *byssus*, an excretion by which many molluscous animals more or less permanently attach themselves to other bodies, and has no affinity to a shelly valve; unless we adopt Professor Lovèn's theory above quoted, and believe the operculum to be a modification of the *byssus*. On the other hand, it may be observed, that the two valves of a Conchiferous mollusk are always united together by a ligament, while the opercula of the Gasteropodous Mollusca are always quite free from the shelly valves; but the importance of this peculiarity disappears when we consider that the two valves of the Brachiopodous Mollusca, which are so perfectly homologous to the valves of the Conchifera in other particulars, are always free and without any ligament; and secondly, that the opercula of one family of Gasteropods, viz. the *Neritinidæ*, are furnished with a peculiar tooth-like process which enables them to move on the sharp inner lip of the larger valve, and greatly resembles the hinge of the valves on the Conchifera. Adanson, describing this kind of operculum, observes, "Il imite parfaitement en cela le second battant des coquillages bivalves."—*Voy. Senegal*, 41.

From these observations I was induced to believe the operculum of a Gasteropodous mollusk to be analogous to the shelly valve of the same animal, and that the shelly valve and the oper-

culum together are homologous to the two valves of a Conchiferous mollusk.

I was also led to believe that the normal or typical form of Mollusca is to be protected by two valves or shells, and I was strengthened in this impression by the discovery that several mollusks which have no shell in their adult state, as the *Doridæ*, &c., have their newly hatched young covered with two shelly valves which afterwards fall off.

With this idea, in the 'Synopsis' of the British Museum for 1842, p. 50, I observed, "By far the greater number of these animals (Mollusca) are provided with two of these shells or valves, which are often nearly alike in size and form, and are hence called *bivalves*, as the shells of the Conchifera, where one of the valves is placed on each side of the body and they are united together by a ligament. In others, as those of the Brachiopods, the two valves are separate, one on the upper surface or back, and the other on the under surface of the body. In others, as in the shells of Gasteropods, the two valves are so unequal that the smaller merely acts as a lid to close the mouth of the larger one when the animal is retracted into it; hence it has been called an *operculum*. This smaller valve or operculum is generally cartilaginous, either wholly formed of animal matter, or strengthened by a quantity of calcareous matter deposited on one or both of its surfaces; sometimes this valve is altogether wanting, especially in those genera which have an expanded mouth compared with the size of the remaining shell. In the bivalve Conchifera and Brachiopoda the two valves are usually nearly equal-sized, and regular in position. On the contrary, in the Gasteropods the valves are unequal, and placed more or less obliquely with regard to the axis of the elongated body of the animal."

If this theory is correct, the operculum should afford an important character for the distinction of families and genera; and this has proved to be the fact.

In 1821 I first drew attention to the very good character which it afforded, not only for the distinction of genera, but also for the division of the genera into larger groups. In my papers published in the Zoological Journal and in the Philosophical Transactions, I collected together the results of my observations on their structure, formation and growth, and their importance to the œconomy of the animal. More recent examinations have only strengthened my conviction, that they afford quite as important characters for the division of families and genera as the shell of the Gasteropods themselves, and that to neglect them in the description of the genus or species is quite as rational as to describe only the single valve of a bivalve shell. If this is the case, no specimen of an operculated univalve, which is not accom-

panied by its operculum, can be considered as complete, and every figure of the species wanting this important part must be equally imperfect; therefore it is much to be regretted that in several expensive modern works on Conchology, their artists and authors have neglected to figure the operculum of the species they have drawn; and especially as many of the specimens figured in Mr. Reeve's work, for example, have been taken from specimens in the Museum, or Mr. Cuming's collection, which had their operculum affixed on the shells, the absence of the operculum renders the excellent and characteristic figures contained in that work much less valuable than they otherwise would have been. I may add, the opercula were formerly supposed to be confined to the Gasteropodous Mollusca. They are well developed in the heteropodous genera *Atlanta* and *Oxygyrus*, the one being annular and the other spiral; and in the genus *Limacina* (or *Spirialis*) among the Pteropodous Mollusca. Some have supposed that the fossil Cephalopodous family *Ammonites* are provided with one, as an operculum-like body is often found in the cavity of these shells.

XLIV.—*On* Cannabis indica, *Indian Hemp*. By Alexander Christison, F.B.S.E., Member of the Royal Medical Society*.

The object of the present communication is to give some account of the Indian Hemp, a substance which has been long used in the Indian and Persian empires as a medicinal and intoxicating agent, but which was unknown to Europeans, except through the reports of travellers, until of late years. It was first brought into prominent notice by Dr. O'Shaughnessy of Calcutta in the year 1839.

It would be beyond the scope of this paper to enter minutely into the early history of the plant, but it may be observed that the narcotic properties of *Cannabis indica* were unknown to the Greek physicians. In the year 600 the Hindoos were in the habit of employing it, since which time it has been in constant use as a means of allaying pain, and more particularly as an intoxicating drug, among the inhabitants of the East. Hemp would seem to have been known at a still earlier period to the Chinese; in a communication to the Académie des Sciences in the early part of this year by M. Stanislas Julien, extracts are given from a Chinese work, showing that so far back as A.D. 220, a Chinese physician named Howshoa produced insensibility in his patients by means of a preparation of hemp, and that operations were then performed without pain to the patients. The veracity of this statement may however safely be questioned.

Until the year 1839 the properties of Hemp were never investigated in this country, but the essay of Dr. O'Shaughnessy published at that time attracted attention to the subject, and many experiments with

* Read before the Botanical Society of Edinburgh, April 11, 1850.